REMARKS

Prior to examination, Applicants respectfully request entry of this Amendment in which the specification and abstract have been amended to correct minor informalities. Pursuant to 37 C.F.R. § 1.121(b)(1)(iii), a marked-up version showing the amendments thereto is attached. No new matter has been added. Applicants believe the case is now in condition for examination.

Claims 1-65 are pending herein. Applicants have amended the claims to eliminate multiple dependent claims. Pursuant to 37 C.F.R. § 1.121(c)(1)(ii), a marked-up version of claims 1, 6-9, 11-16, 18, 20, 22, 24-31, 33, 35, 37, 39, 41, 44-49 and 51-65 showing the amendments thereto is attached. No new matter has been added. Applicants believe the case is now in condition for examination.

If the Examiner believes that contact with applicants' attorney would be advantageous toward the disposition of this case, he is herein requested to call applicants' attorney at the phone number noted below.

The Commissioner is hereby authorized to charge any additional fees associated with this communication or credit any overpayment to Deposit Account No. 50-1446.

Respectfully submitted,

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Date

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification:

First full paragraph on page 32 has been amended as follows:

In step S7 described above, the pressure applied to the high pressure vessel 30, by introducing the infiltrating gas into the high pressure vessel 30, is not less than 0.98 MPa and not more than 202 MPa. In this case, the pressure is preferably not less than 4.9 MPa and not more than 202 MPa, and more preferably not less than 9.8 MPa and not more than 202 ~~MP~~ MPa.

Paragraph at page 32, line 26 -- page 33, line 5, has been amended as follows:

As for the pores of the porous sintered member ~~20~~ 12, as described above, it is desirable that those having an average diameter of 0.5 to 50 μm exist by not less than 90 % by volume, and the porosity is 10 to 50 % by volume.

Paragraph at page 37, lines 6-13, has been amended as follows:

As shown in FIG. 6, the furnace 60 ~~is generally used to make a graphite material into the graphite form. The furnace 60~~ has inside thereof a space 72 capable of setting a case 70, and a heater 74 used to heat the case 70 set in the space 72. The case 70 is composed of, for example, a material such as graphite, ceramics, cerapaper (heat-insulating material composed of ceramics such as alumina). The graphite is set in the case 70.

Paragraph at page 47, lines 5-15, has been amended as follows:

As shown in FIG. 15, the heat sink material 10C according to the third embodiment is constructed by pressurizing a mixture obtained by mixing powder 12b of carbon or allotrope thereof and a binder (binding agent) etc. to prepare a preformed product ~~and~~or a block (preferably having a cubic, rectangular parallelepiped, or arbitrary configuration), and

infiltrating the block with the metal. The same powder 12b as the powder 12a of carbon or allotrope thereof used in the second embodiment may be used. The heat sink material 10C can be manufactured to have an arbitrary shape which is approximate to the final shape.

Paragraph at page 51, lines 9-22, has been amended as follows:

Next, explanation will be made with reference to FIG. 18 for a sixth production method for the heat sink material 10a according to the third embodiment. In the sixth production method, at first, molten metal 14 obtained by melting metal or metal in a solid-liquid co-existing state (solid-liquid co-existing metal) is prepared (step S701). In this procedure, the term "solid-liquid co-existing metal" refers to one obtained by making metal (generally alloy) be in a semi-molten state or one obtained by cooling and agitating molten metal into a semisolidified state. That is, the term refers to both of a metal in the semi-molten state obtained by heating and a metal in the semisolidified state obtained by completely melting and being cooled afterwards.

Paragraph at page 55, line 23 -- page 56, line 6, has been amended as follows:

The compressive strength of carbon (standard: JIS R 1608, method for testing compressive strength of fine ceramics) is 24.5 to 34.3 MPa (250 to ~~35~~350 kgf/cm^2) in the surface direction and 34.3 to 44.1 MPa (350 to 450 kgf/cm^2) in the thickness direction. Therefore, according to this experiment, it has been confirmed that no problem arises in production even when the infiltration pressure having four to five times the carbon compressive strength is applied in the infiltrating step.

In the Claims:

Claims 1, 6-9, 11-16, 18, 20, 22, 24-31, 33, 35, 37, 39, 41, 44-49 and 51-65 have been amended as follows:

1. (Amended) A heat sink material comprising carbon or allotrope thereof and metal ~~(14)~~,

wherein an average coefficient of thermal conductivity of those in directions of orthogonal three axes, or a coefficient of thermal conductivity in a direction of any axis is not less than 160 W/mK.

6. (Amended) The heat sink material according to ~~any one of claims~~ claim 1, ~~3, and 5,~~ wherein said heat sink material is constructed by infiltrating a porous sintered member ~~(12)~~ with said metal ~~(14)~~, said porous sintered member ~~(12)~~ being obtained by sintering said carbon or said allotrope thereof to form a network.

7. (Amended) The heat sink material according to claim 6, wherein a porosity of said porous sintered member ~~(12)~~ is 10 to 50 % by volume, and an average pore diameter is 0.1 to 200 μm.

8. (Amended) The heat sink material according to claim 6 ~~or 7~~, wherein as for volume ratios between said carbon or said allotrope thereof and said metal ~~(14)~~, said volume ratio of said carbon or said allotrope thereof is within a range from 50 to 80 % by volume, and said volume ratio of said metal ~~(14)~~ is within a range from 50 to 20 % by volume.

9. (Amended) The heat sink material according to ~~any one of claims~~claim 6 ~~to 8~~, wherein an additive is added to said carbon or said allotrope thereof for decreasing a closed porosity when said carbon or said allotrope thereof is sintered~~,~~.

11. (Amended) The heat sink material according to ~~any one of claims~~claim 1,~~3, and 5,~~ wherein said heat sink material is constructed by infiltrating a preformed product with said metal~~(14)~~, said preformed product being prepared by mixing water or a binder with powder ~~(12b)~~ of said carbon or said allotrope thereof, and forming an obtained mixture under a predetermined pressure.

12. (Amended) The heat sink material according to claim 11,

wherein an average powder particle size of said powder~~(12b)~~ of said carbon or said allotrope thereof is 1 to 2000 μm, and

wherein a length ratio is not more than 1:5 between a direction in which said powder ~~(12b)~~ has a minimum length and a direction in which said powder~~(12b)~~ has a maximum length.

13. (Amended) The heat sink material according to claim 11~~or 12~~, wherein as for volume ratios between said carbon or said allotrope thereof and said metal~~(14)~~, said volume ratio of said carbon or said allotrope thereof is within a range from 20 to 80 % by volume, and said volume ratio of said metal ~~(14)~~ is within a range from 80 to 20 % by volume.

14. (Amended) The heat sink material according to ~~any one of claims~~claim 1,~~3, and 5,~~ wherein said heat sink material is constructed by mixing powder ~~(12b)~~ of said carbon or said allotrope thereof with said metal~~(14)~~ dissolved into a liquid state or a solid-liquid co-existing state to obtain a mixture, and casting the obtained mixture.

15. (Amended) The heat sink material according to ~~any one of claims~~claim 6~~to 14~~, wherein a closed porosity is not more than 12 % by volume.

16. (Amended) The heat sink material according to ~~any one of claims~~claim 6~~ to 15~~, wherein an element for improving wettability at an interface is added to said metal~~ (14)~~.

18. (Amended) The heat sink material according to ~~any one of claims~~claim 6~~ to 17~~, wherein an element for improving reactivity with said carbon or said allotrope thereof is added to said metal~~ (14)~~.

20. (Amended) The heat sink material according to ~~any one of claims~~claim 6~~ to 19~~, wherein an element, which has a temperature range of solid phase/liquid phase of not less than 30 °C, is added to said metal~~ (14)~~ in order to improve molten metal flow performance.

22. (Amended) The heat sink material according to ~~any one of claims~~claim 6~~ to 21~~, wherein an element for lowering a melting point is added to said metal~~ (14)~~.

24. (Amended) The heat sink material according to ~~any one of claims~~claim 6~~ to 23~~, wherein an element for improving said coefficient of thermal conductivity is added to said metal~~ (14)~~.

25. (Amended) The heat sink material according to claim 24, wherein an element for improving said coefficient of thermal conductivity is added to said metal~~ (14)~~, an alloy of the element and said metal~~ (14)~~ is obtained by segregation or the like after a heat treatment, processing, and reaction with carbon, and the alloy has a coefficient of thermal conductivity of not less than 10 W/mK.

26. (Amended) The heat sink material according to ~~any one of claims~~claim 1~~ to 5~~, wherein said heat sink material is constructed such that powder ~~(12a)~~ of said carbon or said

allotrope thereof is mixed with powder ~~(14a)~~ of said metal ~~(14)~~ to obtain a mixture and the obtained mixture is formed under a predetermined pressure.

27. (Amended) The heat sink material according to claim 26, wherein an average powder particle size of said powder ~~(12a)~~ of said carbon or said allotrope thereof and said powder ~~(14a)~~ of said metal ~~(14)~~ is 1 to 500 μm.

28. (Amended) The heat sink material according to ~~any one of claims~~claim 1 ~~to 5~~, wherein said heat sink material is constructed such that a pulverized cut material of said carbon or said allotrope thereof is mixed with powder of said metal ~~(14)~~ to obtain a mixture and the mixture is formed at a predetermined temperature under a predetermined pressure.

29. (Amended) The heat sink material according to ~~any one of claims~~claim 26 ~~to 28~~, wherein as for volume ratios between said carbon or said allotrope thereof and said metal ~~(14)~~, said volume ratio of said carbon or said allotrope thereof is within a range from 20 to 60% by volume, and said volume ratio of said metal ~~(14)~~ is within a range from 80 to 40 % by volume.

30. (Amended) The heat sink material according to ~~any one of claims~~claim 26 ~~to 29~~, wherein said coefficient of thermal conductivity is not less than 200 W/mK, and a coefficient of thermal expansion is 8×10^{-6} to 14×10^{-6}/°C.

31. (Amended) The heat sink material according to ~~any one of claims~~claim 26 ~~to 30~~, wherein an additive making it possible to perform re-sintering after formation, is added to said carbon or said allotrope thereof.

33. (Amended) The heat sink material according to ~~any one of claims~~claim 26~~ to 32~~, wherein a low melting point metal for improving wettability at an interface is added to said metal~~ (14)~~.

35. (Amended) The heat sink material according to ~~any one of claims~~claim 26~~ to 34~~, wherein an element for improving reactivity with said carbon or said allotrope thereof is added to said metal~~ (14)~~.

37. (Amended) The heat sink material according to ~~any one of claims~~claim 26~~ to 36~~, wherein an element having a temperature range of solid phase-liquid phase of not less than 30 °C is added to said metal ~~(14)~~ in order to improve molten metal flow performance.

39. (Amended) The heat sink material according to ~~any one of claims~~claim 26~~ to 38~~, wherein an element for lowering a melting point is added to said metal~~ (14)~~.

41. (Amended) The heat sink material according to ~~any one of claims~~claim 1~~ to 40~~, wherein a carbide layer is formed on a surface of said carbon or said allotrope thereof.

44. (Amended) The heat sink material according to ~~any one of claims~~claim 1~~ to 43~~, wherein said metal~~ (14)~~ is at least one selected from Cu, Al, and Ag.

45. (Amended) The heat sink material according to ~~any one of claims~~claim 1~~ to 44~~, wherein a ratio of coefficient of thermal conductivity is not more than 1:5 between a direction in which said coefficient of thermal conductivity is minimum and a direction in which said coefficient of thermal conductivity is maximum.

46. (Amended) A method of producing a heat sink material, comprising the steps of:

sintering carbon or allotrope thereof to form a network for obtaining a porous sintered member~~ (12)~~;

infiltrating said porous sintered member~~ (12)~~ with metal~~ (14)~~; and

cooling said porous sintered member~~ (12)~~ infiltrated with at least said metal~~ (14)~~.

47. (Amended) The method of producing said heat sink material according to claim 46, wherein in said sintering step, said carbon or said allotrope thereof is placed in a vessel, and an interior of said vessel is heated to produce said porous sintered member~~ (12)~~ of said carbon or said allotrope thereof.

48. (Amended) The method of producing said heat sink material according to claim 46~~ or 47~~, wherein in said infiltrating step, said porous sintered member ~~(12)~~ is immersed in molten metal of said metal~~ (14)~~ introduced into a vessel, and said porous sintered member~~ (12)~~ is infiltrated with said molten metal by introducing infiltrating gas into said vessel to pressurize an interior of said vessel.

49. (Amended) The method of producing said heat sink material according to claim 48, wherein force of said pressurization is four to five times as strong as a compressive strength of said porous sintered member~~ (12)~~ of said carbon or said allotrope thereof, or less than four to five times the compressive strength of said porous sintered member~~ (12)~~.

51. (Amended) The method of producing said heat sink material according to ~~any one of claims~~claim 46~~ to 50~~, wherein in said cooling step, said infiltrating gas in a vessel is vented, and cooling gas is quickly introduced to cool an interior of said vessel.

52. (Amended) The method of producing said heat sink material according to ~~any one of claims~~claim 46~~ to 51~~,

wherein said sintering step includes a step of setting said carbon or said allotrope thereof in a case~~ (70)~~, and a step of preheating an interior of said case~~ (70)~~ to prepare said porous sintered member ~~(12)~~ of said carbon or said allotrope thereof, and

wherein said infiltrating step includes a step of setting said case ~~(70)~~ in a mold ~~(82)~~ of a press machine~~ (62)~~, a step of pouring molten metal ~~(86)~~ of said metal ~~(14)~~ into said case, and a step of forcibly pressing said molten metal~~ (86)~~ downwardly with a punch~~ (84)~~ of said press machine~~ (62)~~ to infiltrate said porous sintered member~~ (12)~~ in said case~~ (70)~~ with said molten metal~~ (86)~~.

53. (Amended) The method of producing said heat sink material according to claim 52, wherein a pressure of said forcible pressing by said punch~~ (84)~~ is four to five times as strong as a compressive strength of said porous sintered member~~ (12)~~ of said carbon or said allotrope thereof or less than four to five times the compressive strength of said porous sintered member~~ (12)~~.

54. (Amended) The method of producing said heat sink material according to claim 53, wherein said pressure of said forcible pressing by said punch~~ (84)~~ is 1.01 to 202 MPa (10 to 2000 atmospheres).

55. (Amended) The method of producing said heat sink material according to claim 53~~ or 54~~, wherein said mold~~ (82)~~ is formed with a gas vent hole for venting any remaining gas in said porous sintered member~~ (12)~~ or formed with a gap for venting gas.

56. (Amended) The method of producing said heat sink material according to ~~any one of claims~~claim 46~~ to 55~~, wherein in said cooling step, said heat sink material, in which

said porous sintered member ~~(12)~~ is infiltrated with said metal ~~(14)~~, is cooled by cooling gas blown thereagainst or by using a cooling zone or a cooling mold where cooling water is supplied.

57. (Amended) A method of producing a heat sink material, comprising the steps of:

mixing water or a binder with powder ~~(12b)~~ of carbon or allotrope thereof to obtain a mixture;

forming the obtained mixture into a preformed product under a predetermined pressure; and

infiltrating said preformed product with metal ~~(14)~~.

58. (Amended) A method of producing a heat sink material, comprising the steps of:

mixing powder ~~(12a)~~ of carbon or allotrope thereof with metal ~~(14)~~ dissolved into a liquid state or a solid-liquid co-existing state to obtain a mixture; and

casting the obtained mixture.

59. (Amended) A method of producing a heat sink material, comprising the steps of:

mixing powder of carbon or allotrope thereof with powder ~~(14a)~~ of metal ~~(14)~~ to obtain a mixture ~~(104)~~; and

pressurizing the obtained mixture ~~(104)~~ placed in a mold of a hot press machine ~~(102)~~ at a predetermined temperature under a predetermined pressure to form into said heat sink material.

60. (Amended) A method of producing a heat sink material, comprising the steps of:

mixing powder of carbon or allotrope thereof with powder ~~(14a)~~ of metal ~~(14)~~ to obtain a mixture ~~(104)~~;

preforming the obtained mixture ~~(104)~~ to prepare a preformed product ~~(106)~~; and

pressurizing said preformed product ~~(106)~~ placed in a mold of a hot press machine ~~(102)~~ at a predetermined temperature under a predetermined pressure to form into said heat sink material.

61. (Amended) A method of producing a heat sink material, comprising the steps of:

mixing a pulverized cut material of carbon or allotrope thereof with powder ~~(14a)~~ of metal ~~(14)~~, and preforming to prepare a mixture ~~(104)~~; and

pressurizing said mixture ~~(104)~~ placed in a mold of a hot press machine ~~(102)~~ at a predetermined temperature under a predetermined pressure to form into said heat sink material.

62. (Amended) A method of producing a heat sink material, comprising the steps of:

mixing a pulverized cut material of carbon or allotrope thereof with powder ~~(14a)~~ of metal ~~(14)~~ to obtain a mixture ~~(104)~~;

preforming the obtained mixture ~~(104)~~ to prepare a preformed product ~~(106)~~; and

pressurizing said preformed product ~~(106)~~ placed in a mold of a hot press machine ~~(102)~~ at a predetermined temperature under a predetermined pressure to form into said heat sink material.

63. (Amended) The method of producing said heat sink material according to ~~any one of claims~~claim 59~~ to 62~~,

wherein said predetermined temperature is relatively -10 °C to -50 °C with respect to a melting point of said metal~~ (14)~~, and

wherein said predetermined pressure is 10.13 to 101.32 MPa (100 to 1000 atmospheres).

64. (Amended) The method of producing said heat sink material according to ~~any one of claims~~claim 59~~ to 63~~, wherein said heat sink material is heated to a temperature of not less than a melting point of said metal~~ (14)~~ after said pressurizing step.

65. (Amended) The method of producing said heat sink material according to ~~any one of claims~~claim 46~~ to 64~~, wherein said metal~~ (14)~~ is at least one selected from Cu, Al, and Ag.

In the Abstract:

The abstract has been amended as follows:

ABSTRACT

Graphite is placed in a case~~ (70)~~, and the case is set in a furnace~~ (step S301)~~. The interior of the furnace~~ (60)~~ is subjected to sintering to produce a porous sintered member~~ (12)~~ of graphite~~ (step S302)~~. After that, the case ~~(70)~~ with the porous sintered member~~ (12)~~ therein is taken out of the furnace~~ (60)~~, and is set in a recess of a press machine~~ (62) (step S303)~~. Subsequently, molten metal~~ (86)~~ of metal~~ (14)~~ is poured into the case~~ (70) (step S304)~~, and then a punch~~ (84)~~ is inserted into the recess to forcibly press the molten metal~~ (86)~~ in the case~~ (70)~~ downwardly~~ (step S305)~~. Open pores of the porous sintered member~~ (12)~~ are

infiltrated with the molten metal ~~(86)~~ of the metal ~~(14)~~ by the pressing treatment with the punch ~~(84)~~.